TECHNICAL NOTE: FEEDING RATE AS A CONSIDERATION FACTOR FOR SUCCESSFUL TERMITE WOOD PREFERENCE TESTS

*Yusuf Sudo Hadi**
E-mail: yshadi@indo.net.id

A. Arinana
E-mail: arinanaiskandaria@yahoo.co.id

Muh Yusram Massijaya
Bogor Agricultural University
Kampus IPB Darmaga
Bogor 16680, Indonesia
E-mail: mymassijaya@yahoo.co.id

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Abstract. The percent weight loss (%WL) of a wood sample and termite mortality are indicators of termite wood preference. WL is apparently affected by wood density, even though the same WL values for wood of different densities provide different amounts of wood mass loss. Feeding rate is also a factor for interpreting the results of termite wood preference tests. The wood species used for this study were sengon (*Paraserianthes falcataria*), pulai (*Peronema* sp.), and mindi (*Melia azedarach*), which had densities of 273, 302, and 434 $kg \cdot m^{-3}$, respectively. Samples of wood from each species were tested against the subterranean termite (*Coptotermes curvignathus* Holmgren) according to the Indonesian standard SNI 01-7207-2006. The WL for sengon, pulai, and mindi were 37.3, 36.4, and 10.3%, respectively; termite mortality was 24.2, 18.8, and 61.3%, respectively; and the daily feeding rates were 270, 132, and 42 μg per termite, respectively. The resistance class relative to the Indonesian standard was V for sengon and pulai and III for mindi. Higher wood density among these three species tended to be more resistant to subterranean termite attack, as indicated by a lower wood WL, higher termite mortality, and lower termite feeding rate.

Keywords: Wood density, feeding rate, weight loss, mortality, subterranean termite.

INTRODUCTION

Applied silviculture tends to produce short-rotation forest stands by planting fast-growing tree species to obtain a high volume of logs in a short time period. The trees are cut between 5 and 10 yr of age, and the logs contain a lot of juvenile wood. This juvenile wood has inferior physical–mechanical properties and is also more susceptible to biodeterioration. Subterranean termites are the most severe biodeterioration agent of wood and wood products, especially in tropical areas.

Indonesian standard SNI 01-7207-2006 (Standar Nasional Indonesia 2006) provides a reference to evaluate the resistance of wood to subterranean termite attack. The percent weight loss (%WL) of a wood sample may be used to evaluate the resistance class of wood with a higher %WL resulting in a lower resistance class. Specifically, class I corresponds to a WL of less than 1.2% (very resistant), while class V has a WL of more than 18.9% (very poor resistance).

A close examination of %WL reveals that it is affected by the initial weight and density of a wood sample. In the test, a wood sample is described by a certain size or volume. Consequently, the %WL value from a low-density wood results in lower total wood weight compared with a high-density wood because the calculation is based on the initial wood weight. Termite feeding capacity is limited by the

* Corresponding author

insects' stomach volume and needed calories, and a termite will not feed more than necessary regardless of an abundance of available food resources.

During the test, termites feed on a certain weight of wood, resulting in a higher %WL for low-density wood and a lower resistance class. In contrast, wood with a higher density might have a lower %WL, resulting in a higher resistance class. Another reference, the Japanese standard JIS K 1571-2004 (Japanese Industrial Standard 2004), requires termite mortality as a measure for evaluating wood preference. If termite mortality for a reference wood is below the standard, it indicates that the test is not valid. It must be repeated to get a better result relative to termite mortality.

Feeding rate describes how much wood each termite consumes per day, and the value is affected by the termites' living environment, wood availability, and other factors that affect termite survival. Arinana et al (2012) reported that the termite daily feeding rates for five wood species (*Acacia mangium*, *Hevea brasiliensis*, *Paraserianthes falcataria*, *Pinus merkusii*, and *Cryptomeria japonica*) varied from 43 to 82 μg per termite based on the Indonesian standard test and from 55 to 129 μg per termite based on the Japanese standard test. Hermawan et al (2012) found that daily termite feeding rates on *Anthocephalus cadamba*, *Peronema canescens*, and *Acacia mangium* ranged from 29 to 90 μg per termite based on the Indonesian standard test.

The current study investigated percent wood weight loss, termite mortality, and feeding rate as factors for subterranean termite tests by comparing three wood species with differing densities.

MATERIALS AND METHODS

Wood Species

Wood species used in this study were sengon (*Paraserianthes falcataria*), pulai (*Peronema* sp), and mindi (*Melia azedarach*), and the wood samples were from a community plantation forest in Bogor, West Java, Indonesia. Five replications of wood samples were prepared for testing.

Testing Method According to SNI 01.7202-2006

The test method standard was based on a forced-feeding test using 200 g of sand media, 50 mL of distilled water, and 200 worker termites (*Coptotermes curvignathus* Holmgren) for 4 wk in a dark room. The wood samples were placed inside the jar with the widest end leaning against the jar wall as described previously (Hadi and Tsunoda 2010).

Evaluation of Results

The WL of each wood sample was calculated by the difference in the weights before and after the test period according to Eq 1:

$$\text{Percent weight loss} = (W1 - W2)/W1 \times 100\% \quad (1)$$

where: W1 = weight of oven-dried wood before the test (g)
W2 = weight of oven-dried wood after the test (g)

Based on %WL, the resistance class of the wood was classified as shown in Table 1.

In addition to WL, termite mortality was calculated according to Eq 2:

$$\text{Termite mortality } (\%) = (\text{number of dead workers})/200 \times 100\% \quad (2)$$

Table 1. Resistance classes against the subterranean termites *Coptotermes curvignathus* (Indonesian Standard SNI 01.7207-2006).

Resistance class	Weight loss (%) range
I: Very resistant	<3.52
II: Resistant	3.52–7.50
III: Moderately resistant	7.50–10.96
IV: Poorly resistant	10.96–18.94
V: Very poorly resistant	>18.94

The feeding (wood consumption) rate is helpful for comparing test results obtained by using wood species with different densities. To calculate the feeding rate, we assumed that termites die linearly over time. On the basis of this assumption, feeding rates can be calculated according to Eq 3:

$$\text{Daily feeding rate } (\mu\text{g per termite}) = (\text{weight of wood eaten}, \mu\text{g}) / (\text{average number of living termites}) / (\text{number of days in the test period}) \quad (3)$$

Data analysis used a completely randomized design with a single factor, namely wood species, and Duncan's test was used for further analysis if the factor was significantly different.

RESULT AND DISCUSSION

Wood densities of sengon, pulai, and mindi samples were 273, 302, and 434 $kg{\cdot}m^{-3}$, respectively, and the average and standard deviation of wood density, termite mortality, wood WL, daily termite feeding rates, and resistance class are shown in Table 2. According to the analysis of variance, wood species was highly significant affecting wood density, termite mortality, wood WL, and daily termite feeding rate; further analysis is indicated by superscripts letter in Table 2.

Sengon had the lowest wood density and the fastest tree growth among the three wood species. Sengon logs are used for veneer production, especially for core veneer in plywood manufacturing, although it provides small diameter logs of 20-30 cm harvested from 4- to 6-yr-old forest stands. The other two wood species, namely mindi and pulai, are usually used for light construction or furniture. These three wood species have recently become popular and are planted by the people or the community in support of the wood industry (Ministry of Forestry 2011).

As shown in Table 2, mindi wood had greater resistance to termite attack than the other two wood species, which was indicated by the lowest %WL and higher termite mortality. With regard to %WL, mindi belongs to resistance class III, indicating moderate resistance, and the other two wood species belong to resistance class V, indicating very poor resistance (Standar Nasional Indonesia 2006). With reference to Martawijaya et al (1981, 1989), all three wood species belong to resistance class V or very poor resistance, which was a different result for mindi wood only. This difference could arise from differences in tree age, tree site, or silviculture treatment or from the part of the stem used. As already mentioned, mindi wood has a higher density than wood from the other two wood species with the result that mindi is potentially more resistant than the others. This finding was also reported by Hadi et al (2010) who found that higher wood density was potentially associated with greater wood resistance to subterranean and dry wood termite attacks.

The last parameter of the test is daily feeding rate, which indicates how much wood weight is consumed by each termite per day. Mindi wood had the lowest daily feeding rate followed by pulai and sengon. This trend was inversely related to wood density and wood weight loss; that is, higher wood density had a lower %WL and a lower termite feeding rate.

With regard to feeding rate, a lower %WL for higher density wood is affected by the higher

Table 2. Density, mortality, weight loss, and feeding rate of each wood species.[a]

	Wood species		
	Sengon	Pulai	Mindi
Density ($kg \cdot m^{-3}$)	273 (14)[a]	302 (11)[b]	434 (22)[c]
Mortality (%)	24.2 (7.6)[d]	18.8 (2.8)[d]	61.3 (4.2)[e]
Weight loss (%)	37.3 (9.3)[f]	36.4 (6.8)[f]	10.3 (2.2)[g]
Feeding rate (μg per termite per day)	270 (60)[h]	132 (25)[i]	42 (8)[j]
Resistance class (SNI 2006)	V	V	III

[a] Values in parenthesis are standard deviation. Values with the same superscripted letter in a row indicates a statistically nonsignificant difference.

initial weight of a sample, which undermines the determination of the wood resistance class according to Standar Nasional Indonesia (2006). In this study the daily feeding rates on the three wood species varied broadly, 42-270 µg/termite, because the different wood species embodied variable physical, chemical, and anatomical characteristics. For daily feeding rates, the calculation in this study was based on the average number of living termites at the start and the end of the test or the termite mortality remaining constant through time during the test. The precise feeding rate should be calculated using the actual average of living termites by determining the number of living termites each day instead of the average value over the duration of the test.

CONCLUSIONS

Wood species was highly significant in terms of wood density, termite mortality, wood weight loss percentage, and termite feeding rate. WLs of sengon, pulai, and mindi woods were 37.3, 36.4, and 10.3%, respectively; termite mortality for these wood species was 24.2, 18.8, and 61.3%, respectively; daily feeding rates were 270, 132, and 42 µg per termite, respectively; and resistance class relative to the Indonesian standard were V, V, or very poor resistance, and III, or moderate resistance, respectively. Higher wood density tended to result in greater resistance to subterranean termite attack, which was indicated by the lower percent wood weight loss, higher termite mortality, and lower termite feeding rate.

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